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BY

MOHAMMAD SHARIF, M.Sc., F.R.M.S.,
Lecturer in Zoology, Muslim University, Aligarh

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PREFACE

The work on the external morphology of *Hyalomma œgyptium* was done under the instructions of my kind professors, Mr. George Matthai, M.A., F.L.S., Mr. A. Kumar, M.A., and Mr. B. L. Bhatia, M.Sc., in the Biology Laboratory of the Government College, Lahore. It was completed and re-written in the Biology Laboratory of the Aligarh Muslim University.

I wish to express my thanks to Dr. Zia-ud-Din Ahmad, C.I.E., Pro-Vice-Chancellor, Major E. W. Dann, Principal, Intermediate College, Professor M. Haidar Khan. and Mr. F. D. Murad, all of the Aligarh Muslim University, for the kind assistance they have been giving me in my Laboratory work.

I have the pleasure of acknowledging assistance on special points received from my professors and Mr. M. L. Bhatia, M.Sc., of the Government College, Lahore. The latter gentleman has been kind enough to finish a few of the plates.

ALIGARH MUSLIM UNIVERSITY, }
April 20th, 1923. }

M. SHARIF.

The External Morphology and Bionomics of the Commonest Indian Tick (*Hyalomma œgyptium.*)

(*Received for publication on 26th July 1923.*)

Introduction.

THE study of ticks has recently attracted the attention of many parasitologists on account of the serious diseases which they cause in animals, such as the domestic fowl and most mammals, including man.

More than eighteen species have been recorded to transmit pathogenic parasites in man and domesticated animals. Various kinds of cattle-fever, of which Rhodesian fever, Texas fever and Red-water fever are well known, are caused through the agency of ticks. In these cases they play exactly the same role as the mosquito does in malarial fever. It would not be wrong to say that if there were no ticks there would be no disease in cattle.

Rocky Mountain fever is transmitted by ticks which attack man at night time.

Ticks are very common in tropical countries and are found on almost every mammal. India possesses a large number of species, many of which are probably still undescribed. Human ticks are found in the Madras Presidency where Dr. Oliver was the first man to record them, but the present writer has not come across such ticks in the Punjab. A number of serious diseases are associated with ticks and it is more probable that further investigations may bring to light a still larger number of diseases caused through their agency.

Ticks belong to the Class Arachnida, Order Acarina, which is characterized by the degeneracy of structures. The abdomen is unsegmented and is broadly fused with the thorax. The basal pieces of the pedipalps are united behind the mouth, but those of the following segments are widely separated and have no gnathobases.

The Super-family Ixodoidea includes ticks in general. The commonest of the Punjab cattle-ticks, whose description is intended to be given in the following pages, belongs to the family Ixodidæ. This differs from the other family, Argasidæ, by the presence of a scutum and also in the spiracles being situated posteriorly to the last pair of legs. The capitulum is attached to the extreme anterior end and is visible to its full extent when seen dorsally. This family includes ten genera. They are divided into two main groups according to the situation of the anal groove which surrounds the anus either anteriorly or posteriorly. As in this tick the anal groove surrounds the anus posteriorly it belongs to the group of Metastriata. This again is divided into two sub-groups according to the size of rostrum. The rostrum of this tick is long, hence it can be placed in the sub-group Longistriata, which includes three genera only.

The male of this tick has adanal and accessory shields, hence it cannot belong to the genus *Amblyomma.* The presence of eyes excludes it from the genus *Aponoma.* Thus it belongs to the genus *Hyalomma*, the chief characteristics of which are the following :—

Capitulum long, with basis capituli sub-triangular dorsally and no lateral angles, anal groove present, coxa I bidentate, ornamentation present or absent, when present only confined to legs ; eyes present ; body with or without festoons ; male with a pair of adanal shields, with or without accessory shields and two posterior abdominal protrusions capped by chitinous points ; spiracle comma-shaped.

The scutum is dark brown, hence it cannot be *Hyalomma hippopotamense.* The presence of lateral grooves in the males places it under *Hyalomma œgyptium.* The female, with numerous unequal punctations, strengthens the close resemblance to the species. This tick has been identified by Mr. Warburton, Zoologist to the Royal Agricultural Society. His material was from Firozepur and most of my material is from that place. Moreover, I find that there is no difference between the Lahore and Firozepore ticks.

Hyalomma œgyptium is the commonest Punjab tick and according to Warburton, it is the commonest tick in India. The Indian variety is smaller and less marked than the African variety. As far as my opinion goes there are two varieties here in the Punjab. One is smaller in size and more common on the horse, sheep, goat and cattle. The other larger variety is found mostly on the camel.

In general structure *Hyalomma œgyptium* resembles *Hœmaphysalis punctata* and other ticks. The body is unsegmented and there is no distinction into head, thorax and abdomen. All are fused together to form the body. At the anterior end there is a structure which one is apt to mistake for the head of the tick,but it is not the true head. This is called the capitulum and is formed by the fusion of the mouth parts of the tick.

The sturctures of the various stages show great variations and necessitate separate accounts. Firstly, detailed accounts of the female will b e given and then comparative accounts of other stages.

Technique and methods.

In the study of the external characters of *Hyalomma ægyptium* living specimens were examined and sketched. The coloured figures are true representations of the living specimens. In a majority of cases the drawings are Camera Lucida sketches. Specimens intended for the study of chitinous parts were treated in 10 per cent. cold caustic potash solution. In a majority of cases it was found that the chitinous parts, when placed therein for more than three hours were distorted. Prolonged immersion of any part in caustic potash solution softens the chitin so much that it becomes impossible to get a true idea of the structure. After removal from caustic potash solution, a thorough washing in tap-water was found necessary. Then the specimens were washed in a saturated solution of picric acid in water to which a trace of acetic acid was added. This was found more useful than a direct transference to the last.

Specific and General Account of the Female.

UNFED (Plate I, figs. 1a, 1b.)

GENERAL. The outline of the body of the female tick is elliptical, narrowing anteriorly, the maximum breadth being attained at the level of last pair of legs. The body is dorso-ventrally flattened as is usual in Ixodidæ. In the unfed female it is convex on the dorsal side and flat ventrally. The colour varies from reddish-brown to darkish brown on the dorsal side but is deep brown on the ventral surface. Minute hairs on the general body show no definite arrangement. The whole chitin is thrown into zigzag striations. The length of the female (measured from the anterior end of the scutum to the posterior margin of the body) is 2·87 mm. to 3·79 mm. and breadth (maximum) 1·79 mm. to 2·54 mm. But in camel ticks the maximum length is 4·45 mm. and the maximum breadth is 3·5 mm. At the anterior end of the body there is a depression into which fits a structure formed by the fusion of the basal parts of the mouth appendages, known as the basis capituli.

DORSUM. *Scutum.* This is a chitinous plate attached to the dorsal surface of the lesser anterior half of the body. It is more or less hexagonal in shape with rounded angles. The anterior side is deeply emarginate to receive the neck of the basis capituli. The lateral anterior projections of the scutum are known as scapulæ. They are not pointed, but are also emarginate to receive the posterior lateral rounded surfaces of the anterior portion of the basis capituli. The posterior side of the scutum is curved with the convexity directed backwards.

On the angles between the antero-lateral sides and the postero-lateral sides of the scutum on either side, are found a pair of button shaped eyes sunk into small pits. These eyes are black in colour. This blackness is due to the presence of a black diverticulum of the alimentary canal underneath each eye. The colour of the eye is in reality dirty white. When the diverticulum moves to one side or the other side of the eye, the real colour of the eye can be seen, but in preserved specimens it is always black.

The scutum is glabrous, there being only a few small hairs scattered here and there. The number of pores is larger on the antero-lateral margins. The colour is dark brown, and the punctations are deep, unequal, scattered all over the scutum. These are more numerous external to the cervical grooves described below.

The cervical grooves start from the posterior angles of the depression at the anterior end of the scutum. First they run towards the median line for a short distance and then diverge outwards. They are deep and narrow anteriorly, but wider and shallow posteriorly. The length of the scutum is from 1·69 mm. to 2·04 mm. and the breadth 1·52 mm. to 1·73 mm.

On the general surface of the body there is a number of grooves. They are simply the external indications of the attachments of the muscles to the integument. These muscles run dorso-ventrally, hence the grooves are found on both sides. There are five with additional four grooves on the dorsal surface.

A pair of deep marginal grooves which run along the lateral margins of the body are narrow and well marked. Each starts near the scutum just behind the eye and extends up to the fourth festoon, cutting off externally three festoons.

A single postero-median groove, which runs along the median line, is broader than the marginal groove. This bifurcates posteriorly to enclose the median festoon. Anteriorly it extends up to a little behind the interfoval space.

There is also a pair of accessory grooves, each of which runs on either side of the postero-median groove. These are shallow and much broader posteriorly. They bifurcate posteriorly to enclose the fourth festoon on either side of the median festoon. They are shorter than the median one. Besides these there are four slight grooves towards the anterior region of the body, a pair on either side of the median line ; of these, two may be termed anterior external grooves and the other two the anterior internals. Each external groove starts from the middle of the postero-lateral side of the scutum, curves towards the median line and meets the accessory groove of its side.

The two anterior internal grooves are longer and well marked. They are straight and each starts from the posterior angle of the scutum. They diverge considerably, and each crosses the external groove of its side and goes up to the middle of the first festoon of its side. These four anterior grooves are well developed in the replete female. These have not been described by Dr. Nuttall and his co-workers in the unfed female of *Hœmaphysalis punctata.* They have been described in fed females but not in the unfed ones.

Foveœ. A pair of small circular depressions can be seen on either side of the dorsal median line opposite to the interspace between legs III and IV. They are of a deep brown colour. Into these depressions open numerous small pores. They are said to be sensory in function.

The posterior margin of the body is indented by short grooves running round the margin from the dorsal surface to the ventral surface, defining eleven distinct areas known as festoons.

The median festoon is the smallest and triangular in shape with its apex directed forwards. The fourth festoon of either side is also triangular in shape, but the first, second and third of either side are rectangular in shape and are cut off from the general body by the marginal groove of the side. The fifth festoon is not defined anteriorly. All the festoons are of unequal size and for convenience sake they have been numbered from anterior ones to the median. Thus we have five on either side of the median festoon. The anterior one is counted first and that one near the median is the fifth.

VENTER. On the ventral surface there are four pairs of legs confined to the anterior end of the body. There are four definite grooves on the ventral surface. A pair of genital grooves surround the genital aperture anteriorly and meet each other. They are divergent and do not run parallel to the median line. They are not perfectly straight. Each groove meets posteriorly the middle of the third festoon of its side. They diverge up to the level of the third inter-coxal space, then run parallel up to the fourth intercoxal space, after which they diverge considerably.

The anal groove, which surrounds the anus posteriorly, meets the arms of the genital grooves. It is narrow. The chitin surrounding it is soft and smooth. It becomes white when there is a white secretion of the malpighian tubules accumulated in the rectum. Posteriorly it becomes connected with the post-anal median groove. The latter extends up to the posterior margin of the body where it bifurcates to enclose the median festoon anteriorly. On either side of the post-anal median groove are slight indications of two accessory grooves which are shorter than the median one. These too have not been described by

Nuttall and his co-workers. These in replete female are reduced to merely two dimple-like depressions on either side of the median line. There are two apertures on the ventral side situated on the median line. The anterior one is the genital aperture and the posterior one is the anus.

Genital aperture. (Plate V, fig. 24.) The genital aperture is situated in the mid-ventral line about the level of the second intercoxal space. It moves forwards at the time of oviposition. It is a transverse aperture, and is crescentic in shape with its convexity directed backwards. The lips are of thickened chitin. A chitinous flap, more or less semicircular in shape, arises in front of the aperture and covers the whole of it when required. The chitin of the flap and lips is similar to the general chitin of the body. The chitin surrounding the aperture is sufficiently soft to allow a considerable amount of distension of the aperture, which is required as the male introduces its mouth parts into the vagina at the time of copulation, and also at the time of passing out sufficiently big ova. The surrounding chitin is without hairs. The aperture is sufficiently big at the time of oviposition, so much so that a seeker can easily be inserted.

Anus. (Plate V, fig. 23.) The anus is situated on the median line about one third from the posterior margin. It is a longitudinal slit guarded laterally by a pair of stout anal valves. These are surrounded by a ring of thickened chitin which is known as the annulus. Each valve bears three long hairs towards its posterior end and one towards its anterior end. These hairs guard the anal aperture. The anal valves are semi-lunar in shape, and are simply thickenings of the chitin in that region. These and the annulus are of a brown colour. The valves freely articulate with the annulus through the intervention of softer chitin. When the anal valves move upwards, the aperture is extended, when they are pulled downwards by the muscles attached to the internal surface of the valve, the aperture is closed. The upward and downward movements of the valves can easily be seen under the binocular. The whole anal apparatus is circular in shape.

Spiracles. (Plate IV, fig. 20.) There are two respiratory stigmata or spiracles, situated a little behind the last pair of legs on the lateral margins of the body, a little to the dorsal side. They are more or less comma-shaped. The rod of the comma is very small, hence they can be best described as sub-triangular with an apex directed forward, and with one elongated postero-lateral angle, which is towards the dorsal side. Each consists of a slightly raised plaque with a well-defined margin. The margin is very thin around the elongated postero-lateral angle, but is thickest on the dorsal side of the spiracle. The margin on the ventral side is of the same breadth throughout. The surface of the spiracle is concave with the exception of the structure in the centre, which is known as the macula. The macula is a club-shaped structure with an anterior expanded portion and a posterior narrow elongated portion. The colour of the macula and margin is brown but the space between the two is light yellow. The area between the macula and the margin is full of pores which are more or less circular in shape. The macula bears a slit-like opening known as the ostium. The ends of the ostium are bent towards the ventral surface so as to give it a more or less crescentic shape, with the convexity directed towards the dorsal surface. There is also a lid to cover the ostium when required. The outline of the end of the columella can also be seen. It is elongated in the direction of the long axis of the macula with its extremities bent to give it a crescentic shape, and with its convexity directed towards the ventral surface. The margins have also pores which are known as marginal pores.

Legs. (Plate I, fig. 1*b*.) There are four pairs of legs attached to the ventral surface of the anterior half of the body. While walking, the two anterior legs are directed forwards and the two posterior ones are directed backwards. When the tick is alarmed, it folds its legs and applies them to the sides and in this way it feigns death.

The legs are ornamented. The colour of the legs is brown with alternating white rings. Each leg is divided, as is usual in Ixodidæ, into six segments and a foot. The proximal two-thirds of each segment is brown and distal one-third is white. This gives an ornamented appearance to the legs.

The coxa, the first segment of the leg, is firmly attached throughout its length to the ventral surface of the body. It fits in an aperture of the same outline on the ventral surface of the body. Coxa I is bidentate, and the dentation is very deep. This is the characteristic of the species. There are two spurs attached to the coxa, of which the anterior one is shorter than the posterior one. The coxa bears a few hairs of which the longest is borne on the posterior outer angle. The coxæ are more or less rectangular in shape. The angles towards the median line are rounded.

Coxæ II & III each bears a single small spur on its posterior side, more towards the external angle. Coxa IV has a very rudimentary spur. The outer end of each coxa is depressed to receive the Trochanter, which is the smallest segment. It is as long as it is broad and is cylindrical in shape and is covered with a few scattered hairs. On its distal end there is a cup-shaped depression into which the proximal end of the femur fits. The proximal portion of the femur is separated from the distal greater portion by a constriction, constituting a pseudo-articulation. The two following segments, known as the tibia and the pro-tarsus, are of the same length and are equal in length to the distal portion of the femur. They are cylindrical in shape. The proximal end of each is narrower than the distal end. The diameter increases gradually to its maximum at the distal end.

The distal segment, the tarsus is also divided into two parts by a pseudo-articulation. In tarsus I the proximal portion is about three times the distal portion. The proximal portion is narrower at its proximal end and wider at its distal end. But the reverse is the case with the distal portion. The proximal portion bears near the distal end Haller's organ which is sensory in function. The distal portion bears near its proximal end the accessory pit. In the remaining three tarsi the proximal portion is one-third of the distal portion. The distal portions of all the four tarsi taper obliquely and are provided with two spurs on the ventral side.

The hairs are arranged in longitudinal rows on these segments.

The foot is composed of two parts. The proximal portion is the caruncle, which is proximally attached to the end of the distal portion of the tarsus. It expands distally. With the distal end of the caruncle articulates the pulvillum, which is expanded distally to form the pad of the foot. To the dorsal side of the pad is attached a pair of horny claws.

CAPITULUM. (Plate III, figs. 8, 9 and Plate IV, fig. 16.) The head-like sturcture at the anterior end of the body is known as the capitulum. It has sometimes wrongly been called the head of the tick. The true head is fused with the body and is indistinguishable from it. It is a highly specialized structure bearing the mouth and its appendages. Its length varies from 0·85 mm. to 1·13 mm. It consists of four parts. (1) Basis capituli, (2) a pair of palps, (3) a pair of Cheliceræ, (4) Hypostome.

Basis capituli. This is the posterior part of the capitulum which is formed by the fusion of the proximal portions of the mouth parts. It is sub-rectangular in shape. On its dorsal surface there is a transverse ridge which divides it into an anterior and a posterior portion. The latter is narrow and neck-like, and fits into the depression at the anterior end of the body known as the Camerostome. The capitulum is capable of upward and downward movements. When the capitulum is raised up, the dorsal ridge touches the scutum, and the narrow neck-like posterior portion is concealed. One advantage of the dorsal ridge is that it checks the unnecessary upward movement of the capitulum. The posterior portion is smooth and bears no hairs dorsally, but it bears about eight small hairs in a row along the margin on either side of the ventral surface. There are also a few pores. The cavity of the capitulum communicates with the cavity of the body by a posteriorly-placed capitular foramen.

To the internal surface of the lateral walls and the upper walls of the capitular foramen are attached muscles which converge posteriorly, and are attached to the lower surface of the scutum. These muscles have a fan-shaped appearance. It is by the contraction of these muscles that the capitulum is raised up.

The anterior portion of the basis capituli, when viewed dorsally, is like a trapezium in shape. The posterior angles of this are pointed and slightly directed forwards. This is flat on the dorsal surface but convex on all three sides. The dorsal ridge in this species is well marked and runs transversely up to the postero-lateral margins. It is more or less curved with the convexity directed backward.

On the ventral side there is a similar ridge but it is less pronounced. This is known as the ventral ridge. It is semicircular in shape with the convexity directed backward.

On the dorsal surface on either side of the median line there are big, shallow, oval depressions into which open numerous pores. These are known as *porose areas* and are supposed to be sensory in function. About two very fine hairs may be seen amongst the pores. The major axes of these do not run parallel to the median line but are inclined to it. There are a few hairs on the dorsal surface, mostly confined to the angles. There are also pores scattered on both the sides. On the ventral surface towards the anterior end of the basis capituli, close to either side of the median line, is a pair of Hypo-stomal hairs. Internal to these, exactly on either side of the median line, is a pair of Hypo-stomal pores.

Palps. From the antero-lateral angles project a pair of club-shaped appendages known as the palps. These are borne on cylindrical projections of the basis capituli. Each palp is composed of four segments, known as articles.

The first article is smaller than the two following. It is cylindrical in shape, and is as long as it is broad. The proximal end of this fits into a depression at the anterior surface of the basis capituli. The dorsal surface of the distal portion of the first article is concealed by a projection of the second article. On the ventral surface there is a chitinous plate fused with it. This plate bears six to eight long hairs on its internal margin and one in the middle. This is very long and covers the proximal portion of the second article and also covers the projection of the basis capituli. The second article is the largest of the four. It is club-like with a narrow proximal portion and a broader distal portion. The three sides (dorsal, ventral, and external) have convex surfaces. The internal lateral side is deeply concave. Dorsally it sends a backward projection which covers the distal end of the first article. The arrangement of hairs is very complicated.

On the dorsal surface we have :—(*a*). On the dorsal surface of the supra-internal margin there are 1-2 hairs, (*b*) on the ventral surface of the supra-internal margin there are 3-4 hairs, (*c*) on the external margin 3-4 hairs, (*d*) antero-median, one hair.

On the ventral surface we have (*a*) on the infra-internal margin 6-8 hairs, (*b*) on the infra-external margin 2-3 hairs.

The third article is smaller than the second, and is of the same breadth throughout. Distally it ends bluntly. It is convex on three sides and deeply concave on the mesial side. On the ventral side, toward its distal end, there is a big oval depression bounded by slightly raised margins. Into this fits the fourth article, which is the smallest and is cylindrical and stumpy in shape, bearing 8-10 short sensory hairs on its crown and about five long hairs on its sides.

The internal lateral surfaces of the second and third articles are concave, so that, when the palps come close to each other, they ensheath the hypostome and cheliceræ. There are a few pores scattered on the articles of the palps. The arrangement of the hairs on the third article is definite. There is one terminal hair. On the dorsal surface of the supra-internal margin there are three hairs, two on its ventral surface, one median and two on the supra-external side. On the ventral side we have three infra-internal hairs and one infra-external hair.

Hypostome. (Plate III, fig. 9.) It is the ventral prolongation of the basis capituli, and surrounds the mouth ventrally. It is spatulate in outline, and is divided into two similar halves by a longitudinal fissure. The proximal one-fourth of this is smooth and the distal three-fourths is provided with six files—three on each half—of denticles overlapping one another from before backwards in the manner of roof tiles. Each file has got about 22 denticles. The number of rows and denticles in each row is fairly constant, but it shows some irregularity in the proximal portion where an additional row of denticles may come in and thus increase the number of files. These additional denticles are very few in number. The denticles differ very considerably in shape and size from one another. Proximally there are about eleven denticles in each file, which are small and rectangular in shape. The distal nine or ten denticles in each file are triangular in shape with the apex directed backwards. They are much bigger than the proximal denticles, In continuation with the distal extremity of the Hypostome is a plate of chitin variable in size bearing very minute denticles of irregular size and arranged in transverse rows. This is known as the Corona and it is well-developed in this species.

Chelicerœ (Plate III, figs. 8, 9 and Plate IV, fig. 17) are a pair of club-like appendages roofing the mouth on its dorsal side. The anterior end of the basis capituli is prolonged into a couple of tubes which ensheath the whole of the cheliceræ when retracted, but normally in a free state the distal portions of these project a little out of the two sheaths. When, however, the animal attaches itself to the skin of the host the cheliceræ can protrude for a considerable distance outwards. The distal two-thirds of each cheliceral sheath is covered on its dorsal and lateral areas by a large number of minute denticles arranged in oblique transverse rows, and lying close to one another thus giving an appearance to describe which the term "Shagreened sheath" has been suggested. The proximal end is devoid of denticles and is firmly fused with the basis capituli. The distal end of the sheath is attached a little posteriorly to the surface of the articulation of the digit on the shaft. The terminal portion of the sheath is soft and flexible and is capable of being introverted when the shaft is drawn in. In this way a temporary hood of the sheath is made for the protection of the digit. The shaft is very long, so much so that it extends through the capitular foramen in the body cavity. It is a hollow club-shaped structure, the proximal one-third of which is greater in diameter. The walls of this portion are very thin. The cavity of this portion is occupied by a large number of muscles which are attached to its walls. From these muscles proceed anteriorly a pair of tendons which are inserted in the bases of the digits and are meant for their movements. The proximal ends of the shafts are incised for the attachment of the rectractor muscles of the Cheliceræ.

The distal portion has thick chitinous walls. It is cylindrical in form and narrow in diameter. The distal extremity of the shaft is thickened internally to form the articulating surface for the base of the digit.

At the junction of the distal and the proximal portions of the shaft there is a more or less rectangular area of soft and thin chitin which surrounds the shaft on the dorsal and the lateral sides.

The digits which form the chief cutting apparatus of the tick are situated at the anterior ends of the shafts. Each digit is composed of two moveable articles. The internal article is larger and has got an expanded base which articulates with the anterior surface of the shaft. The distal end of the article is long and narrow and resembles a cutting lancet with a hooked end. The distal hooked point is directed laterally. This article is hollow, and its cavity communicates with the cavity of the shaft, and it also communicates with the exterior by two pores. One is on the internal side and the other on the external side. The internal pore is at a higher level than the other. The cavity extends up to the top of the article but it does not seem to communicate with the exterior by a pore. Professor Nuttall thinks that possibly there is a pore, but in my opinion there is no such pore. The surface covering the canal is so thin that when the article is pressed the upper surface is broken and as the result of that there appears a pore at the tip. The pore he has observed may be due to a similar cause. On the dorsal surface of the internal article near its distal end there is a depression into which fits the dorsal process which is crescentic in shape, the dorsal arm of the crescent having an additional small cusp. In the middle of the crescent there is a pore not mentioned by Messrs. Nuttall, Robinson and Cooper. The arms of the crescent are directed laterally. The external article is smaller than the internal article and articulates with its expanded base. There is a depression on the anterior side of the expanded base of the internal article into which fits the proximal end of the external article which is a chitinous plate, the external margins of which are incised to form a series of three pointed cusps of which the proximal is the largest and the distal is the smallest. It is hollow and its cavity communicates with the cavity of internal article. The digit is surrounded on its internal side by a delicate hood of membranous projection of the walls of the shaft. This hood slopes down on the external side of the digit in such a way as to expose the cutting apparatus of the chelicera.

GORGED FEMALE. (Plate I, figs. 2*a*, 2*b*.)

The body is ovoid, the maximum breadth being attained at the level of the last pair of legs. It is distended considerably and attains a length of about 19·8 mm. and a breadth of 11·5 mm. The colour is variable. It is slate-blue on the ventral side and bluish-grey on the dorsal side.

There are certain dark blue dots scattered all over the body. These secrete a fluid which is sticky and gives out an offensive odour. When the animal is touched the fluid comes out of the skin in drops. This may be considered a defensive contrivance of the passive, replete female. Marginal grooves and festoons are absent, but are indicated in fresh specimens by streaks of bluish colour. The marginal groove is no more a marginal groove but it is only a line of slate-blue colour.

The median and the two accessory grooves are well defined and deep. The two pairs of anterior grooves are well developed. The foveæ are brown in colour, visible to the naked eye on either side of the posteromedian groove. The genital grooves are well developed. The postanal groove is slightly indicated, but the ano-median groove is well developed. The two "Dimple-like depressions" on either side of the ano-median groove near the posterior margin represent the remnant of the ventral accessory grooves.

The genital aperture is considerably shifted forward and lies nearer to the first intercoxal space. This is an adaptation for egg-laying.

Integument. The chitin of the general body is not smooth, but bears a large number of parallel chitinous ridges, running in a zigzag manner. The space between the ridges is narrow in the unfed female but is much greater between the ridges of the fed female, this extension in spaces between the ridges results in the extension of the body in the replete female; the distance between the two ridges of the unfed female is about 5 μ but in the fed female the distance is about 40 μ. There are numerous pores on the body which are thought to be openings of the hypodermal glands by Messrs. Nuttall, Robinson and Cooper.

Male.

UNFED. (Plate I, figs. 3*a*, 3*b*.)

Length (measured as in female) 2·5—3·3 mm.; breadth (maximum) 1·5—2·0 mm.; but in camel ticks the maximum length is 4·5 mm., and breadth (maximum) 3·5 mm.

Body oval as in female, the maximum breadth being reached in the posterior one-third. Convex dorsally, slightly concave on the ventral side.

The scutum covers the whole dorsal surface. Its colour varies from deep brown to dark brown. It is smooth, glabrous, without any hair. The punctations are deep and unequal and irregularly scattered over the surface. The scapulæ are as in the female. The lateral margins of the scutum are entire but the posterior margin is indented, corresponding with the number of the festoons. The median indentation is very deep and, as a result of that, the median festoon is white. The eleven festoons have eleven small chitinous plates attached to their posterior margins. They are more or less semicircular in shape. They bear pores of unequal size. The anterior pair of these eleven and the median festoon-plates are rudimentary. Besides these, there are numerous minute plates, each bearing one pore. The cervical grooves are deep anteriorly, shallow and divergent posteriorly. The lateral groove run along the margins of the scutum, and are shallow anteriorly but deep posteriorly; they start near the eye and end near the second festoon on either side of the median groove, as in the female.

The accessory grooves are shallow and wide anteriorly, but are much wider and deeper posteriorly. Anteriorly each accessory groove joins the cervical groove of the side. From the junction runs a groove anteriorly and outwardly to reach the margin of the scutum.

Foveæ. These are small, oval depressions opposite to the interspace between legs III and IV. On the ventral surface the chitin is of dirty white colour and is soft. The ridges are low and well separated. The number and size of hairs on the ventral surface is much greater than in the female. On the ventral surface there are several minute chitinous thickenings bearing pores.

The genital grooves are divergent and deep. They do not reach the posterior margin, but their arms run along the outer side of the adanal plates. The Post-anal and Ano-median grooves are as in the female.

Genital aperture. (Plate V, fig. 25.) In the male this is a transverse slit, slightly curved with the convexity directed forward. A flap-like apron projects from the anterior end to cover the genital aperture. Posterior to the genital aperture there is a chitinous crescentic plate with its convexity directed backward, bearing a few pores; this plate gives rigidity to the posterior lip of the genital aperture, and this may be considered as a secondary sexual character. The genital aperture is on the second intercoxal space. The anus is as in the female.

Legs. These are similar to those of the female, the only difference being in the size of the tarsal spurs which are strongly developed in the male. Coxa I is deeply bidentate. Second and third coxal spurs are as in female. Fourth coxal spur is very rudimentary.

Spiracle. (Plate V, fig. 21.) This is comma-shaped, with the rod of the comma very much elongated and directed dorsally. The margin of the spiracle is of the same breadth all around except at the posterior end, where it is extremely thin. The macula is small as compared with the length of the spiracle. It is an elongated structure with the anterior end broadened, and is in the centre of the ball of the comma. There is no ostium. The columella is crescentic with its convexity directed toward the ventral side.

CAPITULUM. (Plate III, figs. 10 and 11.) Length (measured as in female) 0·8 mm.—1·2 mm. The capitulum of the male differs from that of the female and requires a separate description. The anterior portion of the *basis capituli* is rectangular in shape and is like that of the female. The dorsal ridge is conspicuous and bears at either extremity a short backwardly-directed process known as the cornu. There are no porose areas, their place being taken by a few scattered pores. Besides these pores there are a few scattered hairs. The palps are comparatively broader, otherwise they are similar to those ot the female. The arrangement of hairs is similar to that of the female.

The Hypostome is as in the female. The Cheliceræ (Plate IV, fig. 18) are like those of the female, but there are slight differences in the digits. The internal article is like that of the female. The dorsal process is crescentic, with the dorsal arm longer than the ventral arm. From this runs downward a strap-like process which becomes fused indistinguishably with the dorso-external side of the internal article. The external article is small with only two cusps, of which the distal is very small. The colour of the rostrum is deep brown.

GORGED MALE.

The gorged male differs in no way from the unfed one. The size is increased to a very slight extent. The scutum does not allow the body of the male tick to expand length-wise. The abdomen bulges beyond the lateral margin of the scutum to a slight extent. The colour of the ventral surface becomes more white and transparent, so much so that the contraction and expansion of the diverticula of the alimentary canal can easily be seen with the naked eye. A fully gorged male is sub-triangular in shape with the base towards the posterior margin. The colour changes from deep brown to dark brown. The maximum size that it can reach is about 6 mm.

Nymph.

UNFED. (Plate II, figs. 4*a*, 4*b*.)

Length (measured from the tips of the palps to the posterior margin) 1·3 mm.—1·58 mm., breadth (maximum) 0·696 mm.—0·833 mm.

The body is oval, narrowing anteriorly. The maximum breadth is reached in the posterior one-third of the body. It is reddish brown on the dorsal side but of a lighter colour on the ventral side. The grooves on the dorsal surface are similar to those of the female but are slightly marked.

The *scutum* is broader than it is long, pentagonal in shape with rounded angles, with the shortest side facing forwards and deeply emarginate to receive the capitulum ; the two antero-lateral sides are the longest and are of equal size ; the two postero-lateral sides are small and the angle between them is considerably rounded. The eyes are situated at the angles between the lateral sides and are white in colour, but become black owing to the presence of the diverticula underneath them, as mentioned before. The cervical grooves are broad and deep and do not reach the posterior margins of the scutum. The colour of the scutum is pale-brown with very fine punctations; it is divided into minute polygonal areas by slight fissures. It covers the anterior one-half of the body.

The *foveæ* are very small and bear about three pores each. The posterior margin is divided into eleven festoons, as in the female; the grooves marking the festoons are not very deep.

The ventral surface of the nymph resembles that of the female. The genital aperture is very rudimentary and is represented by a slight depression on the median line at the level of the second intercoxal space. The genital and the anal grooves are as in the female.

Anus. Each valve bears two hairs on its posterior end and a single one near the anterior end. It is circular in shape.

Spiracle. (Plate V, fig. 22.) This is more or less oval in shape, the broader end facing anteriorly. The margins are very narrow and without marginal pores. The macula is circular and eccentric, being more towards the anterior side. The longer axis of the spiracle is inclined to the longitudinal axis of the body at an angle of about forty-five degrees. There is no ostium.

Legs. The colour of the leg is light brown. It is not ornamented as in the adult. The legs are similar to those of the adult with slight differences. Coxa I has got two spurs, but these spurs differ in shape from those of the adult. There are two cylindrical rods projecting backwards from the posterior margin of the coxa. The two spurs are sufficiently separated. They do not converge anteriorly and join each other, as in the adult, but run parallel to each other. Coxæ II, III and IV have got very rudimentary pointed spurs, only visible under high power. All other segments are similar to those of the female. The tarsi bear no spurs at all.

Integument as in female, shows closely set ridges of chitin with scattered hairs and pores.

CAPITULUM. (Plate III, figs. 12 and 13.) Length (measured as in female) 0·3—0·4 mm. The capitulum of the nymph differs from that of the adult. The dorsal and the ventral ridges are well developed. The anterior portion of the *basis capituli*, when viewed dorsally, is sub-triangular in shape with the lateral angles pointed. There is no porose area.

The palps are as long as the hypostome. Four articles of each palp can easily be distinguished. There is no fusion between the 1st and the 2nd articles, as in the nymph of *Hæmaphysalis punctata*, the first article is comparatively short, and shorter than broad and is concealed mostly on the dorsal side by a projection of the *basis capituli*; it bears a single hair on the infra-internal margin. The second article is the longest and forms two-thirds of the whole length of the palp ; it is narrow proximally and broader distally ; it bears seven hairs, two on the supra-internal margin one on the infra-internal margin and four on the external lateral side, of which two are dorsal and two are ventral in position. The third article is smaller than the 2nd, of the same breadth throughout and blunt anteriorly ; it is not fused with the 2nd article ; the outline of the joint can easily be made out. A projection from the dorsal side of the second article covers the joint and also the proximal portion of the third article dorsally. Article III bears six hairs, three on the supra-internal margin, one on the top, one on the infra-internal margin and one on the external lateral side of the ventral surface. Similar to that of the adult implanted in an oval depression on the ventral surface of the third article is the fourth article. The depression occupies one-half of the ventral surface of the third article. Article IV is small, cylindrical and stumpy, bearing six to seven sensory hairs on its tip and about two hairs on its sides. The palps in general are comparatively longer than they are broad.

Chelicerœ. (Plate IV, fig. 19.) Cheliceræ are similar to those of the female in all respects except that the denticles on the cheliceral sheath are fewer in number.

Hypostome with corona in front bears four files of denticles, about twelve denticle in each row, of which about seven distal denticles have pointed apices and are triangular in shape, but the proximal five are rectangular and are smaller in size. There may be additional denticles, increasing the number of files. The colour of the capitulum is brown, the *basis capituli* deep brown, the anterior portion of the capitulum light brown.

GORGED NYMPH. (Plate I, fig. 7.)

It attains the maximum length of 6 mm. and breadth of 4 mm. It is oval in shape and of a slate-blue colour through which can be seen the white contents of the malpighian tubules. The changes undergone by the nymph are similar to those of the female and are the result of similar causes. There is no indication of marginal grooves or festoons. All other grooves are similar to those of the female. The four anterior grooves are also found in the nymph.

Occasionally there are found certain nymphs which are of a pure milky-white colour. This is due to the feeding of the nymph on the pus. I have also come across a nymph of a pink colour from the ear of a donkey. Pink-coloured nymph are also found on the ears of some horses.

Larva.

UNFED. (Plate II, fig. 5*b*.)

Length (measured from thetips of the palps to the posterior margin) 0·66 mm.—0·8 mm.; breadth maximum) 0·42 mm.—0·49 mm.

The body is oval, narrower anteriorly and wider posteriorly. It is less flattened than in all other stages. The colour of the body is greenish-brown. The postero-median groove and accessory grooves are not well marked. There is no trace of the post-anal or of the genital grooves. Foveæ absent. Spiracle absent. All the grooves are very faintly marked, and rather difficult to make out. In a replete larva, they are well marked and can easily be made out.

The *scutum* is broader than long; length 0·26 mm., breadth 0·38 mm.; colour orange-yellow; it covers nearly the anterior half of the body and follows the outline of the general body in that region; the posterior side of the scutum is curved with the convexity directed backward. The button-shaped eyes are situated on the posterior angles. The lateral margins are straight. The scapulæ are slightly notched anteriorly. The whole of the scutum has on the dorsal surface minute granules visible under a high power. The scutum is glabrous with very few hairs. The cervical grooves are well marked.

The *integument* is as in the female but only the ridges run transversely and are slightly curved, but not zigzag as in the female.

CAPITULUM. (Plate IV, figs. 14 and 15.)

Length (measured as in nymph) 0·156 mm.—0·18 mm. The capitulum of the larva resembles the capitulum of the nymph, but the palps are shorter in proportion to their width. The dorsal ridge divides the *basis capituli* into a posterior neck-like portion and an anterior sub-triangular portion as in the nymph.

There is no ventral ridge nor any porose area. The *basis capituli* is glaborous without any hairs. The palps are very short in comparison with their width, the length being three times the breadth, while in case of the nymph it is five times. The palps are as long as the hypostome. There is a considerable fusion in the articles of the palps. Article I is very small, broader than long, concealed to some extent by the anterior projection of the *basis capituli*; it bears no hair. Articles II and III are fused together, and it is by no means easy to define the line of demarcation. Article II is the longest and forms two-thirds of the whole palp; it narrows proximally and expands distally; it bears seven hairs: four on the dorsal side, of which two are on the supra-internal margin and two on the supra-external margin ; there are three hairs on the ventral side, one on the infra-internal margin and two on the infra-external margin. Article III is smaller than the second and fused with it ; on its ventral side there is a big oval depression which occupies nearly the whole of its ventral surface ; this article bears five hairs : one terminal, three on the supra-internal margin and one on the infra-external margin. Article IV is cylindrical and comparatively longer than in other stages and is more terminal in position ; it bears about eight long sensory hairs on its top and two hairs on its sides near its proximal end.

The *chelicerœ* are as in the female and nymph. All the structures are fully developed. The sheath has minute denticles on one-fourth of its distal region.

The *hypostome* bears four files of denticles. The two inner rows have fewer denticles than the two external ones. There are about seven denticles in each of the two internal rows and about nine denticles in each of the external two.

Legs. Unlike the adults and nymphs, there are only three pairs of orange yellow legs, which, as in the adult, are composed of six segments with a foot. Coxa I has a very small spur near its postero-internal margin. The tarsi are without any spur. The first tarsus bears Haller's organ with an accessory pit. The proximal portion of the first tarsus is longer than the distal, as in the adult, while the reverse is the case in the other two tarsi.

REPLETE LARVA.

It attains a maximum length of 1·75 mm. and breadth of 0·85 mm. The changes undergone are similar to those found in other stages. The colour is slaty blue in certain cases, while in other cases it is reddish. The colour of the larva depends upon the colour of blood on which it has fed. It is white if fed upon pus.

Life-history of Hyalomma ægyptium.

The following observations were made upon the life-history of *Hyalomma œgyptium* at Jaitu (Nabha State) during the summer vacation of 1921 (July, August, September, 1921).

These experiments were carried out on the laboratory method and were supplemented by field observations. These represent the true life-history of the tick about which serious doubts have existed so far.

The female of this tick, when fully gorged (Plate I, figs. 2*a*, 2*b*), drops from the host and goes in search of any crevice that it may come across. It is very bulky and sluggish and cannot climb vertically. It therefore goes in for crevices which are near the ground. There, after a proper rest, it begins to lay eggs.

For my experiments I took eight females on different dates and placed them in wide mouthed bottles (I used pomade vasiline bottles and cobra boot-polish bottles for my experiment) and placed them in dark corners. The mouths were left wide open and all the sides of the bottles were concealed in wet sand. In this way I was able to provide for these females the proper dark surroundings which they have in crevices in hot seasons. These began to lay eggs after nine to twelve days' rest. The number of eggs laid by each individual varied from 6,000 to 8,000. These eggs were laid during a period of about 20 days. The maximum number of eggs laid in one day was 800. The number of eggs laid in the first week is much greater than in the second week. The eggs are of a light-brown colour and are laid in masses. The eggs adhere to one another by a sticky substance secreted by Genes organ. The female, after laying its eggs, is much reduced in size and shrinks. It is incapable of much movement. It dies before the eggs have had time to hatch out. I have found more than one female laying eggs in one crevice. The female, when confined in the bottle, moves for a short time and then rests in the corner with its anterior end facing the corner. The eggs were laid in the corner. The female, after laying its eggs, moves backwards leaving a space for its eggs and thus piling up a big heap of eggs which appears bigger in size than even the female.

The larvæ (hexapod creatures) emerge from the egg after 23-26 days, the time required for hatching the eggs varying according to the temperature. The following *data* will show the variation in time required for hatching.

Eggs laid by the female on	Larvae hatched on	days taken
1. 13-VIII-1921.	5-IX-1921.	23
2. 1-IX-1921 (morning)	24-IX-1921 (evening)	23
3. 1-IX-1921 (night)	24-IX-1921	23
4. 24-X-1921	20-XI-1921.	27
5. 1-III-1921	2-IV-1921.	32

In December the larvæ took more than two months to hatch out. They died of excessive cold. The recently-hatched larvæ have a white rostrum, white legs, and light grey abdomen, which is rounded and not flattened dorso-ventrally. After about twenty days' rest they attain the colour of the larvæ which are ready to attach themselves to the host. The body becomes flattened dorso-ventrally owing to the food-contents in the body being digested. These newly-hatched larvæ are gregarious in habits. They are always found in batches in nooks and corners of the crevices. If once disturbed they will again collect and sit so close to one another as to form a complete crust. After the resting period they leave their homes and go in search of a host. This they do when it is cool outside. They dare not come out in the scorching heat of the sun. The moment they come out in the sun they are doomed. The hot sand and hot earth are sufficient to kill them. I have myself placed larvæ on the sand exposed to the sun, and after running for a very short distance on the sand they succumbed to the hot sand and died. Prof. Nuttall of Cambridge and many others are doubtful about the proper host of the larvæ. They are of opinion that the proper hosts of the larvæ are some unknown species of mammal. One of these authors went so far as to suggest that the host of the larvæ might be some unknown bird. I have been able to find these larvæ as parasites on the ears of the horse, calf, camel, buffalo and on many other soft parts of these animals. Patton and Cragg deny the existence of the larvæ as parasites on calves. I have found that these larvæ disappear altogether from these animals in winter, especially from the middle of November up to the middle of February, as they cannot bear the excessive cold of the winter.

The larvæ after their resting period, during which their appendages are strengthened and the contents of their alimentary canal are digested, seek a host, attach themselves to the soft parts of the body and begin sucking blood. The time required for feeding varies from three to five days. For this purpose I placed larvæ in a muslin bag and tied it around the ear of a horse. The larvæ attached themselves to the ear of the animal and went on feeding till they dropped back into the bag. From this they were transferred to a wide-mouthed bottle. In their natural surroundings they drop to the ground and seek convenient holes or crevices. The replete larvæ are of two different colours, scarlet red or blue.

I have observed that, if the larvæ are fed on pus in a festering wound, their colour after a feed is white. It would, therefore, not be rash to conclude that the colour of the larva is the same as that of its food. The scarlet colour of the replete larvæ may then be due to their feeding upon arterial blood and the blue to their feeding upon venous blood.

The larvæ are quite active for two days but on the third day they become absolutely motionless, so much so that one is apt to take them for dead. After five to seven days the larval skin is torn off by the nymph. The larval skin is white in colour and is left in the sand. A recently-hatched nymph has also the rostrum and legs white, scutum greenish outside the cervical grooves and white between them, and the abdomen chocolate red. The abdomen is not flattened but ovoid. The appendages are very soft and incapable of penetrating the skin. In two days the colour changes from chocolate-red to yellowish-brown. The nymph is ready to attach itself to the host after a rest of five to six days. The muslin bag containing these nymphs was tied to the ear ot a horse. They fed upon the host from five to seven days, after which they dropped from their host as replete nymphs which were placed in a bottle. They were inactive on the third day and the adults came out of the nymphal skin after nine to fifteen days' rest. The replete nymph can climb walls and can search for the crevices in walls a foot or so above the floor. The nymph, owing to its capacity for contraction, can pass through a crevice much narrower than the size of its body.

The recently metamorphosed male and female differ from each other. In the female (Plate II, figure 6*a*) the rostrum and legs are white, abdomen chocolate-red, and scutum bluish-green external to the cervical grooves and light green between the grooves. The male differs from the female in having the ventral side of a light blue colour (Plate II, figure 6*b*). These adults require two to three days for the change of colour in summer, but in winter the process is prolonged. These animals can attach themselves to the host after seven to eight days' rest.

As to the exact amount of time they stay on their host I am not certain.

Both males and females are found upon the same host. They are attached so near to each other that the ventral surface of the one meets the ventral surface of the other. The legs of the one clasp the body of the other. The legs of the female are always in front of those of the male. When the male and female are nearly of the same size they are at right angle to the surface of the attachment, but as the female grows in size the female bends over the male and attaches its legs to the body of the host, while the legs of the male are still clasping the female. The female covers the male so much that at first glance one is apt to notice the presence of the female only. But the male is generally found underneath the female.

Copulation takes place on the host; very rarely it may take place on the ground.

Ticks are very rare on the host in the winter season from mid-November to mid-February. The adults are very rare on animals, absent in majority of cases. But it is impossible to find nymphs and larvæ on the host. Ticks may be found on those animals which have thick fur-like hair, *e.g.*, the camel, during these months. The adults and various other stages are found in crevices but not so abundantly as in the summer months. Ticks, while attached to the host, form a delicious food for crows.

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EXPLANATION OF PLATES.

PLATE I.

1. (*a*) Dorsal and (*b*) ventral views of unfed female of *Hyalomma œgyptium*, ×6. The colour shown is that of the tick when ready to attach to the host.
2. (*a*) Dorsal and (*b*) ventral views of female when fully gorged, ×2.
3. (*a*) Dorsal and (*b*) ventral views of unfed male, ×7.
7. Gorged nymph, dorsal view, ×7.

PLATE II.

4. (*a*) Dorsal and (*b*) ventral views of unfed nymph, ×26. The dorsal view shows the diverticula of the alimentary canal visible through the skin.
5. Unfed larvæ, dorsal views, ×41; (*a*) shows a recently—hatched larva; (*b*) shows larva ready to attach to the host.
6. Recently metamorphosed adults; (*a*) an unfed female, dorsal view, ×6; (*b*) an unfed male, ventral view, ×7

PLATE III.

8. Capitulum of the female, dorsal view, ×41.
9. ,, ,, ventral view, ×41.
10. Capitulum of the male, dorsal view, ×41.
11. ,, ,, ventral view, ×41.
12. Capitulum of the nymph, dorsal view, ×93.
13. ,, ,, ventral view, ×93.

PLATE IV.

14. Capitulum of the larva, dorsal view, ×220.
15. ,, ,, ventral view, ×220.
16. Capitulum of the male, side view, showing that dorsal and ventral ridges are not continuous with one another on the sides, ×41.
17. Left chelicera of female, dorsal view, ×129.
18. ,, ,, male, dorsal view, ×112.
19. ,, ,, nymph, ventral view, ×243.
20. Right spiracle of the female, ×66.

PLATE V.

21. Left spiracle of the male, ×69.
22. Right spiracle of the nymph, ×317.
23. Anus of the female with surrounding chitin showing chitinous ridges, ×69.
24. Genital aperture of female, ×200.
25. ,, ,, male, ×100.

INDEX TO LETTERING ON PLATES.

a. ap.	anal aperture.
an.	annulus.
ant.	anterior.
apr.	apron.
b. c.	basis capituli.
c.	corona.
c. ch. p.	crescentic chitinous plate.
ch.	chelicera.
chi. p.	chitinous plate.
chi. st.	chitinous striations.
cn.	cornu.
Col.	columella.
d.	denticle.
d. ch.	digit of chelicera.
d. p.	dorsal process.
d. r.	dorsal ridge.
e. a. or ex. a.	external article.
ex. pr.	external pore of the internal digit.
g. a. ♀	female genital aperture.
g. a. ♂	male genital aperture.
h.	hypostome.
hd.	hood.
h. h.	hypostomal hairs.
i. a. or int. a.	internal article.
nt. pr.	internal pore on the internal digit.
lid.	lid of the ostium.
l. l.	lower lip of the genital aperture.
m.	margin.
m. p.	marginal pore.
mac.	macula.
os.	ostium.
p.	palp.
p. a.	porose area.
post.	posterior.
pr.	pore.
pu.	punctation.
s. ch.	shaft of the chelicera.
s. chi.	soft chitin.
sh.	sheath of the chelicera.
t. ts.	tendon. tendons.
u. l.	upper lip.
v.	valve.
v. r.	ventral ridge.
1, 2, 3, 4,	1st, 2nd, 3rd, 4th articles.
& 3.	2nd and 3rd articles fused.

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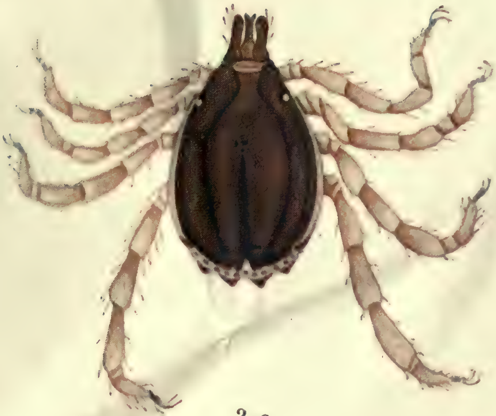
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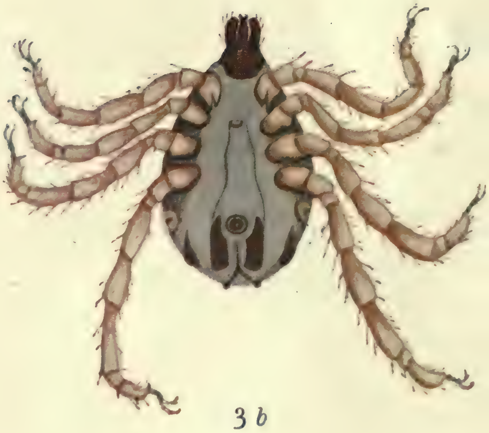
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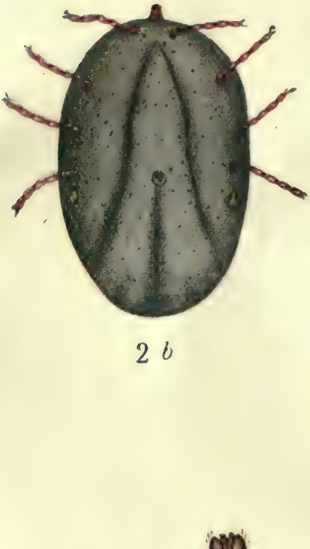
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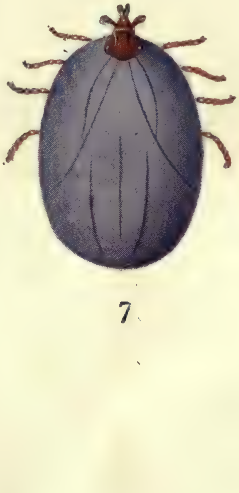
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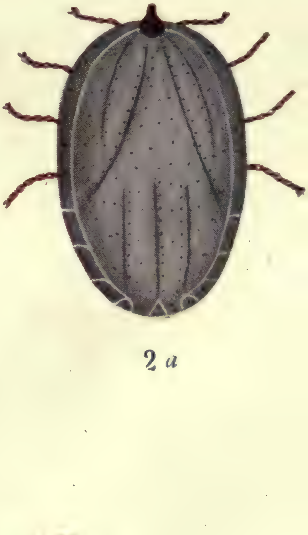
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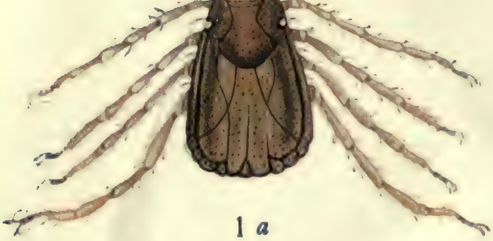
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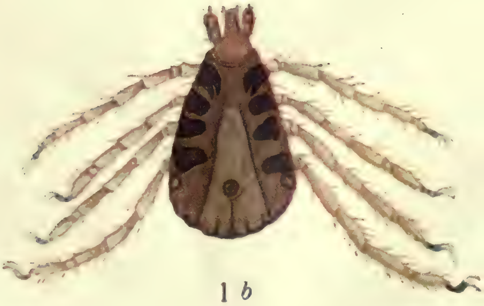
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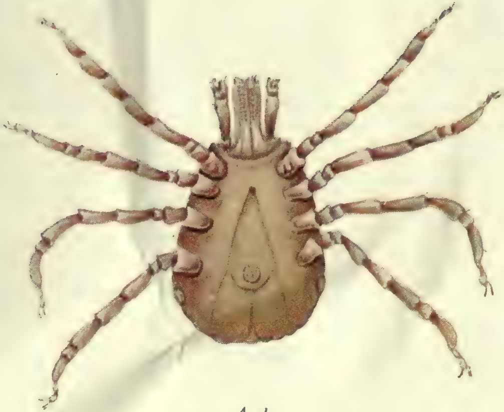

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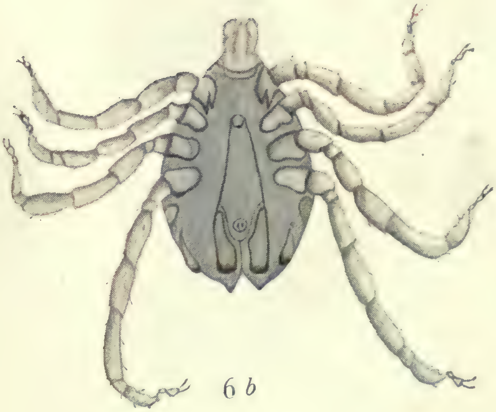

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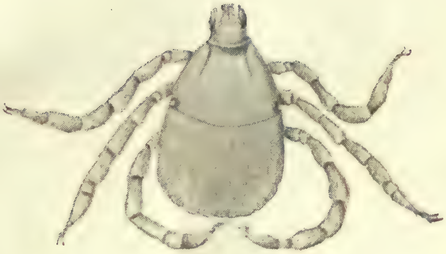

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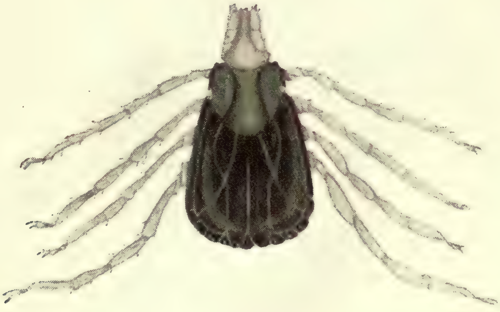

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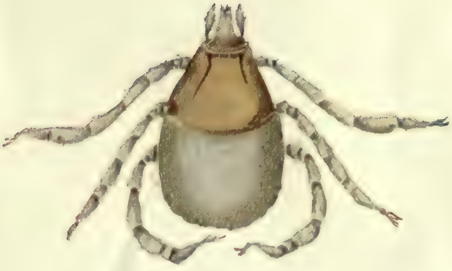

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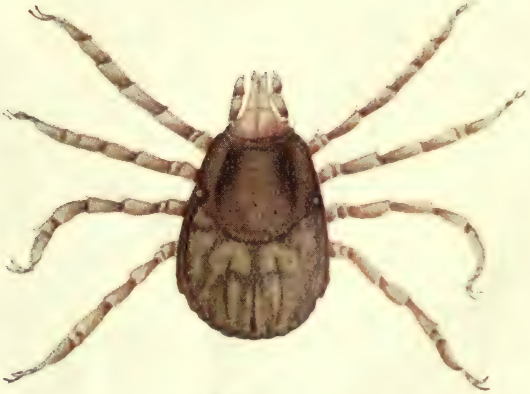

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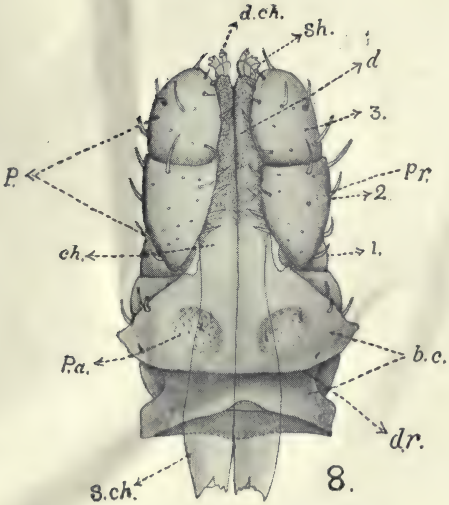

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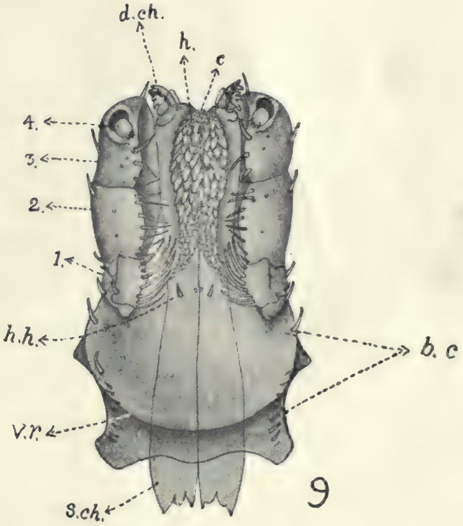

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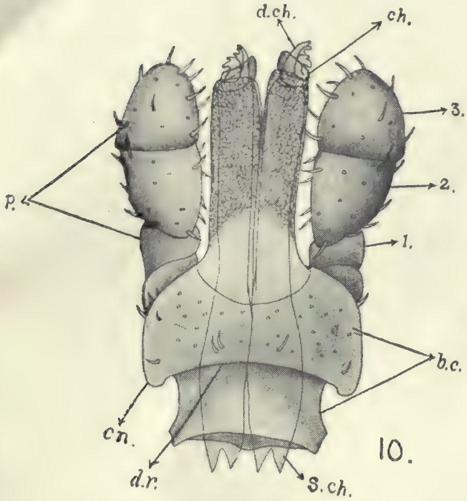

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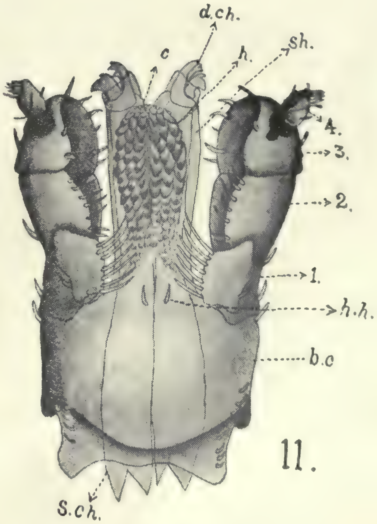

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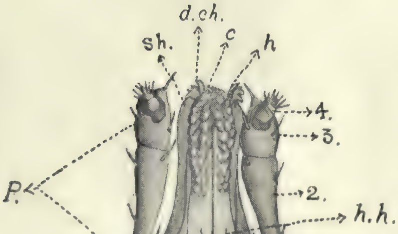

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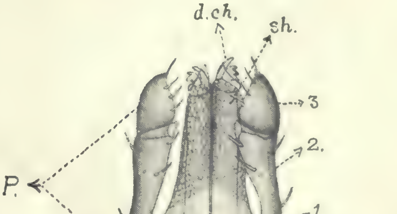

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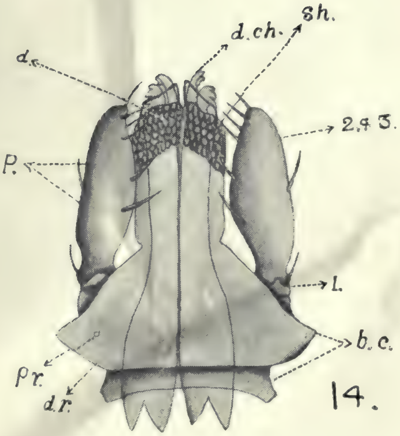

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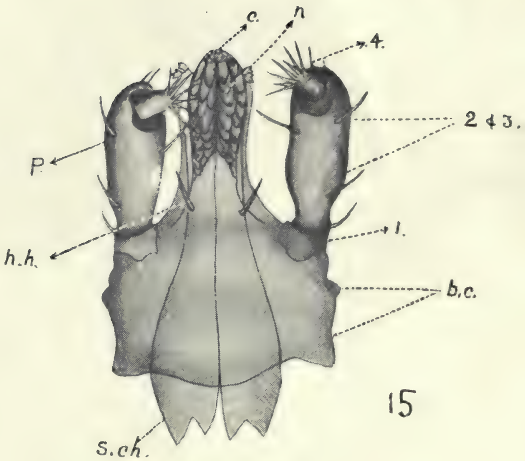

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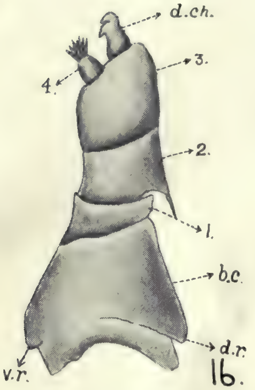

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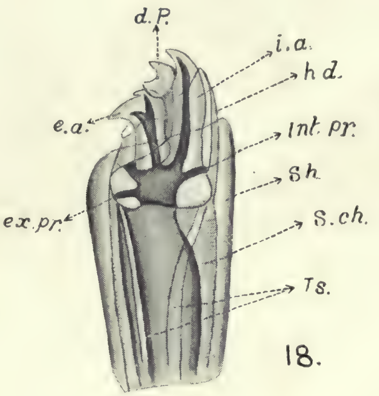

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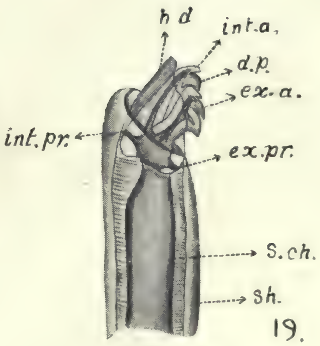

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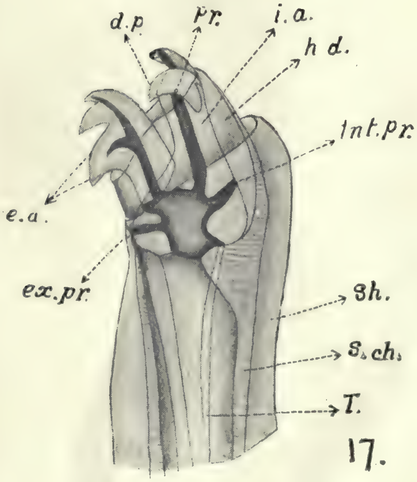

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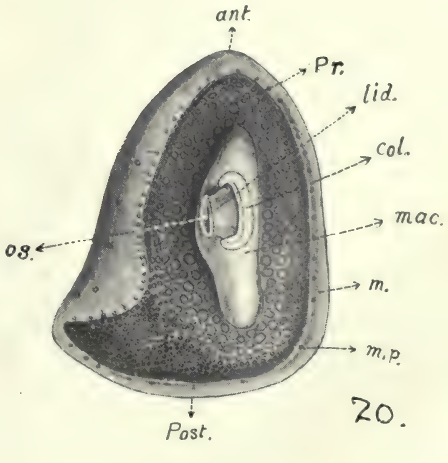

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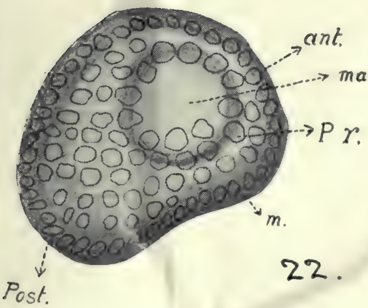

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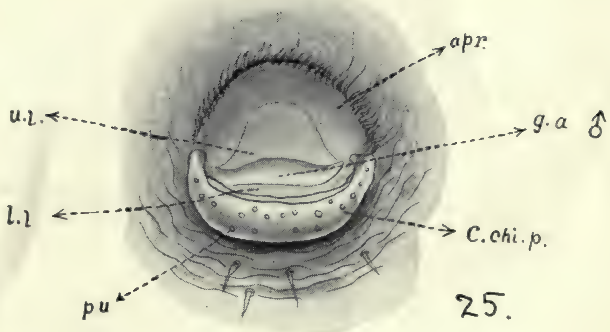

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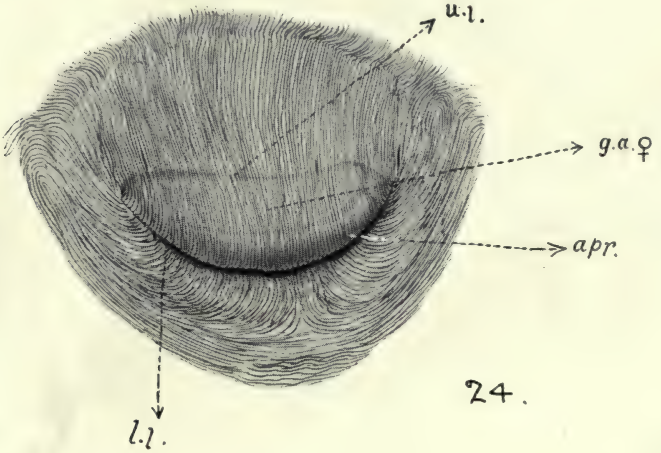

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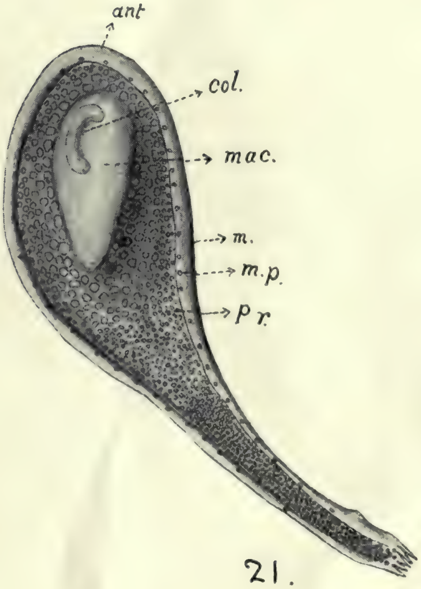

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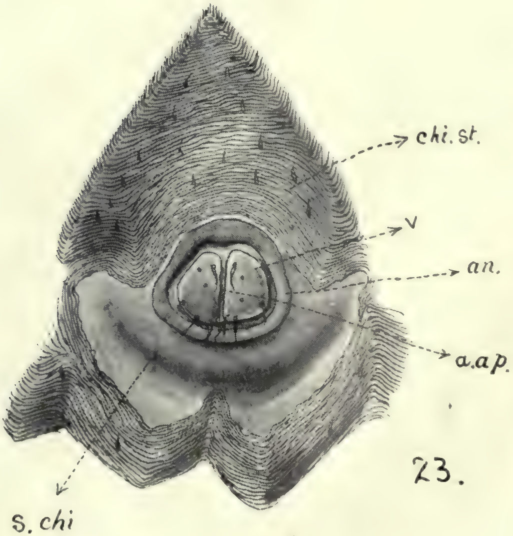

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